WHAT IS CLAIMED IS:

1. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode material comprising a compound having the formula $LiMPO_4$, where M is at least one first-row transition-metal cation.

2. The cathode material of claim 1, where M is further defined as being selected from the group consisting of Mn, Fe, Co, and Ni

3. The cathode material of claim 1, where M is further defined as being a combination of cations, at least one of which is selected from the group consisting of Mn, Fe, Co and Ni.

4. The cathode material of claim 3, where M is $Fe_{1-x}Mn_x$ or $Fe_{1-x}Ti_x$ and $0 < x < 1$.

5. The cathode material of claim 2, wherein the cathode material has the formula $LiFePO_4$.

6. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode material comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_3$, where M is at least one first-row transition-metal cation and $0 \leq x \leq 5$ and Y is ~~Li~~ or Na.

7. The cathode material of claim 5, where M is selected from the group consisting of Fe, V, Mn, and Ti.

8. The cathode material of claim 7, wherein the cathode material has the formula $Li_{3+x}Fe_2(PO_4)_3$, where $0 \leq x \leq 2$.

9. The cathode material of claim 7, wherein the cathode material has the formula $Li_3Fe_2(PO_4)_3$.

10. The cathode material of claim 7, having the formula $Li_{1+x}Ti_2(PO_4)_3$.

11. The cathode material of claim 7, having the formula $Li_2FeTi(PO_4)_3$.

12. The cathode material of claim 7, having the formula $Li_xTiNb(PO_4)_3$, where $0 \leq x \leq 2$.

13. The cathode material of claim 7, having the formula $Li_{1+x}FeNb(PO_4)_3$, where $0 \leq x \leq 2$.

14. The cathode material of claim 7, prepared by the process comprising the steps:

(a) preparing $Na_2Fe_2(PO_4)_3$; and

(b) contacting said $Na_2Fe_2(PO_4)_3$ with a molten lithium salt, such that an ionic exchange reaction occurs.

15. The cathode material of claim 7, prepared by a direct solid state reaction.

16. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode material comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_y(XO_4)_{3-y}$, where $0 < y \leq 3$, M is a transition-metal atom, $0 \leq x \leq 5$, Y is Li or Na, and X = Si, As, or S.

17. The cathode material of claim 16, wherein the cathode material has the formula $Li_{1+x}Fe_2(SO_4)_2(PO_4)$, where $0 \leq x \leq 2$.

18. The cathode material of claim 17, prepared by the process comprising the steps:

(a) preparing an aqueous solution comprising $FeCl_3$, $(NH_4)_2SO_4$, and LiH_2PO_4;

(b) evaporating the solution to obtain dry material; and

(c) heating the dry material to about 500°C.

19. A cathode material for a rechargeable electrochemical cell also comprising an anode and an electrolyte, the cathode comprising a rhombohedral NASICON material having the formula $A_{3-x}V_2(PO_4)_3$, where A may be Li, Na or a combination thereof and $0 \leq x \leq 2$.

20. The cathode material of claim 19, wherein the cathode material has the formula $Li_{2-x}NaV_2(PO_4)_3$, where $0 \leq x \leq 2$.

21. The cathode material of claim 19, prepared by the process comprising the steps:

(a) preparing $Na_3V_2(PO_4)_3$; and

(b) contacting said $Na_3V_2(PO_4)_3$ with a molten lithium salt, such that an ionic exchange reaction occurs.

22. The cathode material of claim 19, prepared by a direct solid-state reaction.

23. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode material comprising a compound having the formula:

$$Li_{x+y}M_{1-(y+d+t+q+r)}D_dT_tQ_qR_r[PO_4]_{1-(p+s+v)}[SO_4]_p[SiO_4]_s[VO_4]_v$$

where

M may be Fe^{2+} or Mn^{2+} or mixtures thereof;

D is a metal in the +2 oxidation state selected from the group consisting of: Mg^{2+}, Ni^{2+}, Co^{2+}, Zn^{2+}, Cu^{2+}, and Ti^{2+};

T is a metal in the +3 oxidation state selected from the group consisting of: Al^{3+}, Ti^{3+}, Cr^{3+}, Fe^{3+}, Mn^{3+}, Ga^{3+}, Zn^{2+}, and V^{3+};

Q is a metal in the +4 oxidation state selected from the group consisting of: Ti^{4+}, Ge^{4+}, Sn^{4+}, and V^{4+};

R is a metal in the +5 oxidation state selected from the group consisting of: V^{5+}, Nb^{5+}, and Ta^{5+};

$0 \leq x \leq 1$;

$0 \leq y, d, t, q, r, p, s, v \leq 1$ where at least one of y, d, t, q, r, p, s, and v differ from 0 and

$$y + d + t + q + r \leq 1;$$

$$p + s + v \leq 1; \text{ and}$$

$$3 + s - p = x - y + t + 2q + 3r;$$

where x is the degree of intercalation during operation of the electrode material, y represents the fraction of lithium ions on the initial Fe^{2+} sites; d represents the fraction of divalent ions (noted as D) on the initial Fe^{2+} sites; t represents the fraction of trivalent ions (noted as T) on the initial Fe^{2+} sites; q represents the fraction of tetravalent ions (noted as Q) on the initial Fe^{2+} sites; r represents the fraction of pentavalent ions (noted as R) on the initial Fe^{2+} sites; p represents the fraction of hexavalent suflur (as discrete SO_4^{2-} tetrahedra) on the initial P^{5+} sites; s represents the fraction of tetravalent silicon (as discrete SiO_4^{2-} tetrahedra) on the initial P^{5+} sites; and v represents the fraction of pentavalent vanadium ions on the initial P^{5+} sites, and M, D, T, Q and R reside in octahedral sites.

24. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising an ordered olivine compound having the formula $LiMPO_4$, where M is at least one first-row transition-metal cation.

25. The battery of claim 23, where M is further defined as being selected from the group consisting of Mn, Fe, Co, and Ni.

26. The battery of claim 23, where M is further defined as being a combination of cations, at least one of said cations being selected from the group consisting of Mn, Fe, Co, and Ni.

27. The battery of claim 26, wherein M is $Fe_{1-x}Mn_x$ or $Fe_{1-x}Ti_x$, where $0 \leq x \leq 1$.

28. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising a modified olivine compound as set forth in claim 23.

29. The battery of claim 28, wherein the anode comprises a compound selected from the group consisting of a metallic lithium, a lithium alloy, a lithium-carbon intercalation compound, a lithium-transition metal mixed nitride of antifluorite and a lithium-titanium spinel having the formula $Li_{1+x+z}Ti_{2-x}O_4$ where $0 \leq x \leq 1/3$ and $0 \leq z \leq 1 - 2x$.

30. The battery of claim 29, wherein said cathode further comprises a conductive additive.

31. The battery of claim 30, wherein said conductive additive is carbon.

32. The battery of claim 29, wherein said cathode further comprises an intercalation material with fast diffusion kinetics.

33. The battery of claim 32, wherein said intercalation material is selected from the group consisting of a lamellar dichalcognenide, a vanadium oxide having the formula VO_x where $2.1 \leq x \leq 2.5$, and a NASICON-related material.

34. The battery of claim 33, wherein said NASICON-related material is selected from the group consisting of $Li_3Fe_2(PO_4)_3$ and $Li_{3-x}Fe_{2-x}Ti_x(PO_4)_3$.

35. The battery of claim 29, wherein said cathode further comprises a polymeric binder.

36. The battery of claim 35, wherein said polymeric binder is selected from the group consisting of a homopolymer of tetrafluoroethylene, a copolymer of tetrafluoroethylene, an ethylene-propylene-diene terpolymer, a polyether, a polyester, a methylmethacrylate-based polymer, an acrylonitrile-based polymer, and a vinylidene fluoride-based polymer.

37. The battery of claim 36, wherein said polymeric binder is a polyether.

13 12
38. The battery of claim 37, wherein said polyether further comprises a salt comprising Li^+ cations.

14 13
39. The battery of claim 38, wherein said polyether is crosslinked.

40. The battery of claim 35, wherein said ~~polymeric binder~~ has an ionic conductivity of between ~~about 10^{-7}~~ and about 10^{-2} (Scm^{-1}) at room temperature

15 13
41. The battery of claim 38, wherein said polymeric binder is swollen by an aprotic solvent.

16 15
42. The battery of claim 41, wherein said aprotic solvent is selected from the group consisting of: ethylene carbonate, propylene carbonate, dimethylcarbonate, diethylcarbonate, methyl-ethylcarbonate, γ-butyrolactone, a tetraalkylsulfamide, a dialkylether of an ethylene glycol having a molecular weight ≤ 2000.

18 16
43. The battery of claim 42, wherein said aprotic solvent is a dialkylether of an ethylene glycol having a molecular weight ≤ 2000.

19 18
44. The battery of claim 43, wherein said dialkylether comprises a mono-ethylene glycol.

20 18
45. The battery of claim 43, wherein said dialkylether comprises a di-ethylene glycol.

21 18
46. The battery of claim 43, wherein said dialkylether comprises a tri-ethylene glycol.

22 18
47. The battery of claim 43, wherein said dialkylether comprises a tetra-ethylene glycol.

23 18
48. The battery of claim 43, wherein said dialkylether comprises an oligo-ethylene glycol higher than a tetra-ethylene glycol.

49. The battery of claim 42, wherein said dialkylether comprises a mixture of mono-, di-, tri-, tetra-, and higher oligo-ethylene glycols.

50. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_3$, where M is at least one first-row transition-metal cation and $0 \leq x \leq 5$ and Y is Li or Na, other than $Li_{2+x}FeTi(PO_4)_3$.

51. The battery of claim 27, where M is selected from the group consisting of Fe, V, Mn, and Ti.

52. The battery of claim 28, wherein the cathode material has the formula $Li_{3+x}Fe_2(PO_4)_3$, where $0 \leq x \leq 2$.

53. The battery of claim 29, wherein the cathode material has the formula $Li_3Fe_2(PO_4)_3$.

54. The battery of claim 28, wherein the cathode material has the formula $Li_2FeTi(PO_4)_3$.

55. The battery of claim 28, wherein the cathode material has the formula $Li_xTiNb(PO_4)_3$, where $0 \leq x \leq 2$.

56. The battery of claim 28, wherein the cathode material has the formula $Li_{1+x}FeNb(PO_4)_3$, $0 \leq x \leq 2$.

57. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_y(XO_4)_{3-y}$, where $0 < y \leq 3$, M is a transition-metal atom, $0 \leq x \leq 5$, Y is Li or Na, and X = Si, As, or S.

58. The battery of claim 34, wherein said cathode material has the formula $Li_{1+x}Fe_2(PO_4)(SO_4)_2$, where $0 \leq x \leq 2$.

59. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising a rhombohedral NASICON material having the formula $A_{3-x}V_2(PO_4)_3$, where A may be Li, Na or a combination thereof and $0 \leq x \leq 2$.

60. The battery of claim 36, wherein the cathode material has the formula $Li_{2+x}NaV_2(PO_4)_3$, where $0 \leq x \leq 2$.

61. A variable optical transmission device comprising transparent semi-conductor coated glass or plastic, and including at least one positive electrode and at least one negative electrode separated by a solid or gel electrolyte, wherein at least one electrode comprises a modified olivine compound as set forth in claim 23.